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U1S S1839 S3011

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(54) **Composite material**

(57) A laminate composite material comprises outer layers 1, of glasscloth sandwiching an inner layer 3 of aramid fibres (eg, Kevlar (R.T.M.)). Either or both of the outer layers may also include carbon fibres. The resultant material is strong and lightweight, while having good fire resistance properties.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig. 1.

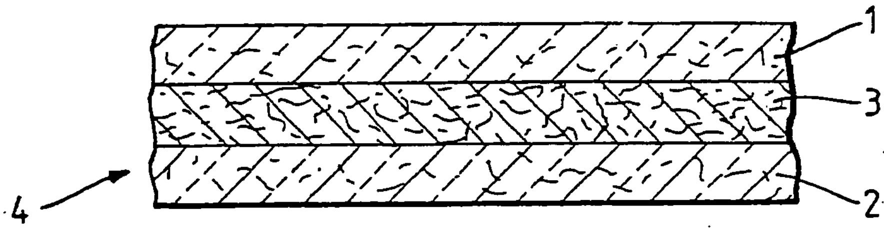


Fig. 2.

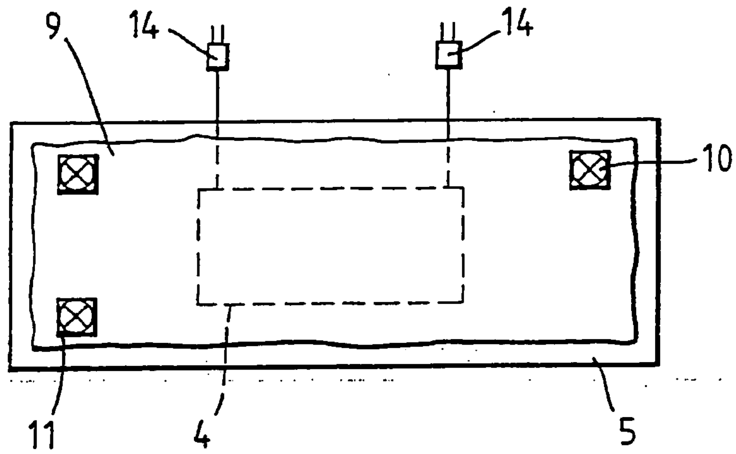
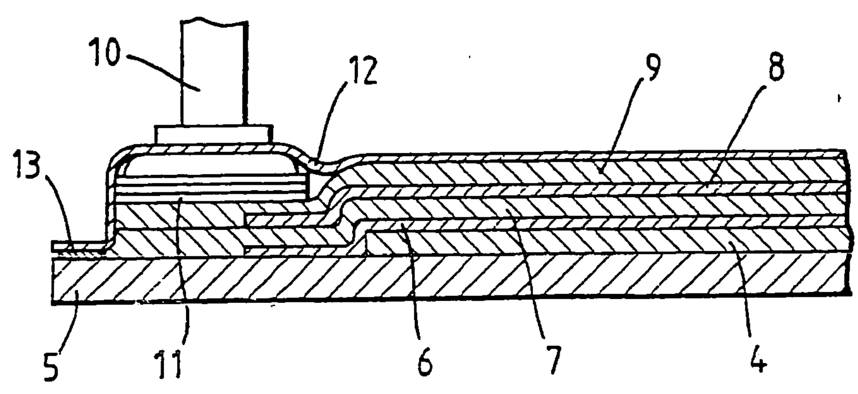


Fig. 3.



COMPOSITE MATERIALS

This invention relates to a composite material, and in particular to a strong, relatively lightweight material having good fire resistance properties.

Conventionally, aircraft interior cabin trim includes furnishing panels formed from synthetic materials. Ideally such materials should be both strong and lightweight, a requirement common to many aircraft components. Increasingly, however, it is becoming a requirement, in certain countries a legal requirement, that materials used in the cabin interior should have good fire resistance properties. In particular, in the event of a fire, such materials should release as little as possible in the way of heat, flame, smoke and toxic fumes.

Meeting all these requirements in one material has presented difficulties. Panels that meet the fire requirements and are lightweight, are generally insufficiently strong and durable. On the other hand strong fire-resistant materials tend to be undesirably heavy. Accordingly it is an object of the present invention to provide a material that is both lightweight and strong, while having good fire resistance properties.

According to the present invention there is provided a laminate composite material comprising a first layer of glass-fibre material, an intermediate layer of strong,

lightweight material and a second layer of glass-fibre material, said layers being bonded by a resin.

Preferably the intermediate layer comprises a layer of aramid fibres, and may be a material such as that sold under the trade name Kevlar by Du Pont. An alternative material for the intermediate layer would be woven carbon fibres or carbon felt, which may also provide advantages in terms of improved acoustic insulation. The outer layers may comprise a glasscloth material and at least one of the outer layers may also include a carbon fibre component for added strength, preferably with a glass/carbon ratio of 2:1.

All the layers may be pre-impregnated with resin prior to being cured. Preferably the resin may be a phenolic resin.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:-

Figure 1 is a section through the material, and,

Figures 2 and 3 are plan and sectional views respectively illustrating a method of forming the material.

Figure 1 illustrates the three layers of the composite material. The outer layers 1, 2 comprise layers of glasscloth pre-impregnated, prior to curing, with phenolic resin. Either or both of these outer layers may also include carbon fibres (with a glass to carbon ratio of 2 to 1) to produce a glasscloth/carbon hybrid layer of greater

strength than glasscloth alone. The intermediate layer 3 is a layer of aramid fibres, again pre-impregnated with phenolic resin. A possible material for this intermediate layer is that sold under the trade name Kevlar (R.T.M.) by Du Pont. It is possible however that other similar lightweight strong materials such as woven carbon or carbon felt, may be employed.

As discussed above, the three layers are all pre-impregnated with phenolic resin. To form an article, a lay-up of the three layers is prepared in a mould tool and then cured. Figures 2 and 3 illustrate this process. The layers to form a component 4 are laid successively on a mould tool 5 that has been cleaned, degreased and then coated with a release agent. The lay-up is carried out on single ply by ply basis and is tailored to suit the contours of the mould tool and the article to be formed. All joints must have a minimum overlap of 0.5" and a maximum overlap of 1.0".

After the lay-up the layers are covered by perforated release film 6, a vacuum breather/resin bleed layer 7, an unperforated release film 8, and a further breather layer 9. Three quick-release vacuum connectors 10 are provided, each resting on three layers of breather material 11. The whole assembly is then covered by a vacuum bag 12 and sealed at the edges by sealing tape 13.

Once prepared the assembly is transferred to an autoclave for the cure cycle. A vacuum of at least 26" Hg is applied to the bag and then positive autoclave pressure of 90psi ± 10psi is applied. When the pressure in the bag reaches 15psi ± 5psi it is vented to atmosphere. The temperature is then raised at a rate of between 1°C-5°C per minute to 150°C, the temperature being monitored by thermocouples 14. The temperature is maintained at 150°C ± 5°C for 30 minutes ± 10 minutes. The temperature is then allowed to cool to 60°C before releasing the autoclave pressure and vacuum and removing the components from the tool.

The number of sub-layers within each of the three layers may be varied depending on the total thickness required of the finished material. Similarly, the relative thicknesses of the three layers may be varied to emphasise particular properties of the material. For example, to produce a relatively strong material the intermediate Kevlar layer may be relatively thick, while for a particularly lightweight layer the outer glass layers may be thicker.